

## About Hexadecimal Numbers

*Bob Brown*

*Computer Science Department  
Southern Polytechnic State University*

Like decimal and binary numbers, the *hexadecimal*, or base 16 number system is a positional number system. We know that there must be 16 symbols, and we choose 0, 1, ..., 9, A, B, C, D, E, and F. Symbols 0 through 9 have the same unit values they have in the decimal system, but of course the positional multiplier is different. Hexadecimal (or *hex*) **A** has the value  $10_{10}$ , **B** is  $11_{10}$ , **C** is  $12_{10}$ , **D** is  $13_{10}$ , **E** is  $14_{10}$ , and **F** is  $15_{10}$ .

The positions in a hexadecimal number have as their values powers of 16, starting with  $16^0$  at the right, then  $16^1$ ,  $16^2$  or 256,  $16^3$  or 4096, and so on. Four hexadecimal digits let us represent numbers up to  $15 \times 16^3 + 15 \times 16^2 + 15 \times 16^1 + 15$ , or  $15 \times 4096 + 15 \times 256 + 15 \times 16 + 15$ , or  $61,440 + 3840 + 240 + 15$ , or 65,535. This number would be represented as FFFF. A value of  $0100_{16}$  is equal to  $256_{10}$ .

Hexadecimal numbers can be used as a kind of shorthand for binary numbers, to avoid writing out long strings of ones and zeroes. Study the following table:

<i>Hex</i>	<i>Binary</i>	<i>Decimal</i>
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
A	1010	10
B	1011	11
C	1100	12
D	1101	13
E	1110	14
F	1111	15

As you can see, each hex digit is exactly equivalent to one of the possible combinations of four binary digits, so we could write  $7_{16}$  instead of  $0111_2$ . This works for numbers larger than four bits or one hex digit.  $7A_{16}$  is equivalent to  $0111010_2$ . Four hex digits let us express a 16-bit binary number in four symbols instead of 16.

It is common to use indications other than a subscript 16 to identify numbers as hexadecimal when it is not clear from the context. The following are all examples of indicators of hexadecimal numbers:  $x'7A'$ ,  $0x7A$ , and  $7Ax$ . In the Motorola 68000 assembler we will be using in Cs2224, hexadecimal numbers are indicated by a dollar sign, so  $\$08$  is  $8_{16}$ .